What We Can Learn About Aerosols from EOS-MISR Multi-Angle Remote Sensing Observations

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Multiangle, multispectral remote sensing observations, such as those anticipated from the Earth Observing System (EOS) Multiangle Imaging SpectroRadiometer (MISR), promise to significantly **improve our ability to constrain aerosol properties from space**.

Recent advances in modeling the Earth's climate have brought us to a point where the contributions made by aerosols to the global radiation budget noticeably affect the results. Knowledge of both aerosol optical depth and the microphysical properties of particles is needed to adequately model aerosol effects. This talk explores the ability of multiangle, multi-spectral remote sensing observations anticipated from the EOS MISR instrument, to retrieve aerosol **optical depth and information about mixes of particle types, globally, at 17.6 km** spatial resolution. The instrument is scheduled for launch into a 10:30 AM, sun-synchronous polar orbit in 1999.

MISR will measure the upwelling visible radiance from Earth in **4 spectral bands** centered at 446, 558, 672, and 866 nm, at each of **9 emission angles** spread out in the forward and aft directions along the flight path at ±70.5°, ±60.0°, ±45.6°, ±26.1°, and nadir. The spatial sampling rate is 275 meters in the cross-track direction at all angles. Over a period of 7 minutes, a 360 km wide swath of Earth comes into the view of the cameras at each of the 9 emission angles, providing a **wide range of scattering angle coverage** for each surface location. In addition to aerosol studies, the data will be used to characterize surface albedo and bi-directional reflectance, and cloud properties. Global coverage will be acquired about once in 9 days at the equator; the nominal mission lifetime is 6 years.

Our **aerosol retrieval approach** involves separating the data into cases where the surface is **dark water**, **dense dark vegetation** (DDV), **heterogeneous land**, or "other" (Martonchik et al., 1998). Retrievals will be performed on data in the first 3 categories. For dark water retrievals, we use the red and near-infrared bands only, where the surface is darkest, and we model surface glitter and whitecap effects as a function of estimated surface wind speed, using standard models. We use the formalism of statistical chi-squared tests to compare the data with simulated instrument radiances in performing the retrieval. Simulations are done for many natural conditions, based on climatological expectations about atmospheric and surface properties.

According to simulations over **cloud-free, calm ocean**, for pure particles with natural ranges of optical depth, particle size, and indices of refraction (Kahn et al., J. Geophys. Res. 1997; 1998)., we can retrieve **column optical depth** for all but the darkest particles, to an **uncertainty of at most 0.05 or 20%, whichever is larger**, even if the particle properties are poorly known. For one common particle type, soot, constraints on the optical depth over dark ocean are very poor. The simulated measurements also allow us to **distinguish spherical from non-spherical** particles, to separate **two to four compositional groups** based on indices of refraction, and to identify **three to four distinct size groups** between 0.1 and 2.0 microns characteristic radius at most latitudes. The technique is most sensitive to particle microphysical properties in the "accumulation mode" sizes, where particle scattering undergoes the transition from Rayleigh to large-particle regimes for the MISR wavelengths.

Based on these results, we expect to **distinguish air masses containing different aerosol types, routinely and globally**, with multiangle remote sensing data. Such data **complements *in situ* and field data**, which can provide details about aerosol size and composition locally. We are extending the sensitivity work to cover mixtures of pure particles.